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How to cite:

French, Fiona; Mancini, Clara and Sharp, Helen (2020). Eine Elefantenperspektive [An Elephant Perspective]. Tierstudien(18) pp. 111–122.

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Version: Accepted Manuscript

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An Elephant Perspective

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Introduction

This research explores the potential for using technology to support the delivery of novel environmental enrichment experiences for elephants housed in captivity. In particular, it aims to enhance their welfare by providing them with meaningful choices and opportunities to control environmental features, thereby offering cognitive and sensory enrichment. Our work falls into the area of Animal-Computer Interaction (ACI: Mancini, 2011), whose aim is designing interactive technology to improve animal welfare and human-animal relations.

Figure 1: Elephant sketch

There has been a significant amount of ACI research using dogs as participants and/or target users of interactive technology, but fewer studies with other, non-domesticated animals, meaning that working with elephants allowed a fresh perspective to be explored. We adapted research methodologies developed by the Product Design, Game Design, User Experience Design and ACI communities over several years, starting with an ethnographic study of captive elephants in 2014 and then making progress with ideation workshops and a *Research through Design and Craft* approach. Collaboration with animal welfare experts has been a key aspect of all our work, contributing to concept development and validation for possible design solutions. In particular, we are indebted to the elephant keepers who supported our endeavours and provided rich feedback on elephant behaviour while we were testing our prototypes.

Motivation

Elephants are known for their cognitive and social complexity, demonstrating sophisticated communication skills, problem-solving abilities and a capacity for empathy (Plotnik, 2010; Poole & Granli, 2008). They are also playful, engaging in locomotor, object and social play all their lives (Lee & Moss, 2014). These behavioural characteristics imply that elephants might be capable and willing to engage with a technologically enhanced playful system as well as potentially benefitting from the experience.

Humans keep small populations of elephants in captivity in zoos worldwide. This course of action enables zoos' mission statements, which typically includes undertaking research and conservation while offering education and entertainment to the public. It is widely accepted that we have a duty of care towards those animals we keep in captivity, which means ensuring that welfare needs are met, by securing the "Five Freedoms" (FAWC Report, 2009):

1. *from* hunger and thirst
2. *from* pain, injury and disease
3. *from* fear and distress
4. *from* discomfort
5. *to display natural behaviours*.

This last freedom may be the hardest to meet, especially for some species, since captivity inevitably reduces an animal's opportunities for freedom of expression – the ability to make choices and to control its actions and environment. Zoos and wildlife parks currently offer their elephants a wide range of low-tech environmental enrichment such as raised baskets of straw (for food and exercise) and hanging tyres (for object and locomotor play), the general purpose of which is to enhance the quality of care by providing stimulation that encourages species-specific behaviours. Our approach to complementing existing enrichment has focused on identifying *gaps* in captive elephants' experience that have not yet been met using traditional solutions, with the aim of using technology to offer something new. Thus, closing some of the elephants' experience gaps has become our design goal. For example, it can be challenging to offer herd animals a truly social experience if they are housed in small numbers. While it is beyond the scope of our work to replicate the experience of living in the wild, we hypothesized that it may be possible to offer the animals enrichment that mitigates some of these privations, albeit in an "artificial" way.

In the wild, female African and Asian elephants live in matriarchal herds all their lives. Males leave the herd as "teenagers" to become independent, often forming bachelor groups. For elephants, living in the herd provides cognitive and sensory stimulation as well as security and purpose. Herds are a close community with a strong hierarchy, where the elephants continuously "talk" to each other in low rumbles (Soltis, 2005). It has been shown that an individual can identify up to seventy other affiliated animals, as well as being able to understand the meaning of the acoustic signals being made and respond appropriately. There may therefore be welfare benefits for captive elephants (with minimal extended family and fewer opportunities for acoustic stimulation) from interventions that afford them the opportunity to engage with a system designed to offer auditory feedback and cognitive stimulation.

Our research explores the design of such systems, with the goal of creating an object that offers elephants the opportunity to engage in playful interactions and perceive different auditory outputs, by allowing them to make choices and exercise control over their experience. Playful behaviour is seen as an indicator of good welfare in captivity (Young, 2003) and is therefore actively encouraged by the inclusion of toys into animal enclosures. Indeed, the British Elephant Welfare Group (EWG, 2020) endorses the idea that captive elephants should be provided with substantial enrichment, including toys. Moreover, an *interactive* toy could invite repeated engagement; learning how to use the device would be cognitively stimulating, and the opportunity to control the output of the device would offer some variety.

Interface design for elephants

Elephants pose an interesting challenge from the perspective of interaction design, because they perceive and interact with the world very differently from humans. This means that the design of any system that requires an "elephant interface" needs to take account of their unique characteristics and preferred interaction modalities. An elephant's primary tool for interacting with the world is an amazingly strong and versatile trunk, which also has olfactory capabilities and is used for auditory signalling. That is very different from a pair of human hands, nose and mouth and therefore requires a novel and well-considered interface design. Humans have fingers and opposable thumbs; elephants have trunks with sensitive tips. Humans usually rely on bifocal vision to perceive and navigate the world, whereas elephants' dominant sense is their phenomenal olfactory ability (Fig. 2).

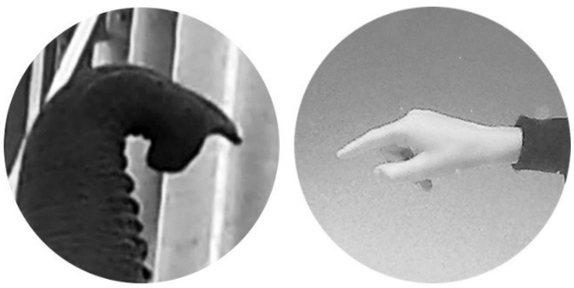

Figure 2: Trunk v. Hand

We approached the challenge from two complementary perspectives: (i) designing and crafting suitable interfaces; (ii) investigating appropriate outputs for an interactive system. *Research through Design* was a useful approach for developing a future product from an evolving concept, allowing us to explore the problem space through design iteration and analysis. The *crafting* aspect of our work proved to be a critical activity that gave us multiple insights regarding the functional and aesthetic dimensions of the systems we were making. Meanwhile, *user-testing* the prototypes with elephants (and their keepers) was invaluable for gaining knowledge about individual preferences regarding modes of interaction and types of feedback. Our main elephant user was Valli, an Asian female housed at Skanda Vale Ashram, a sanctuary in Wales. We also tested prototypes with her companion, Lakshmi, another (blind) Asian female, and with Janu and Machanga, two African males at Noah's Ark Zoo in south-west England (Fig. 3).

Figure 3: Lakshmi following Valli (top) in Welsh countryside; Janu and Machanga in their enclosure.

We began by designing and crafting a series of "buttons" – digital interfaces that offered simple on/off states and that controlled either a water supply or an acoustic output. We installed multiple iterations of button designs in the elephant enclosure over several years, giving us the opportunity to experiment with different technical solutions and physical properties (Fig.

4). Our reflections provided insights for the subsequent prototypes, which we documented in a series of annotated graphical workbooks.

Consideration of the aesthetic aspects of the experience for the elephants became a paramount concern while we were focusing on the digital input devices. It became clear that the tactile quality of the interfaces held the Asian female elephant's interest, no doubt supplemented by olfactory phenomena that we could not appreciate. Valli spent more time feeling the surface texture and the edges of the button frames than using the devices as functional controls. She showed interest in a device that offered haptic feedback, in the form of a small vibrating motor behind the button pad, but initially avoided water or acoustic outputs. This suggested that she took some pleasure in using her trunk for kinaesthetic and haptic perception.

Figure 4: Elephant interfaces

At Noah's Ark Zoo, we installed two "elephant radios" for their African male elephants, each comprising a set of three buttons that played different audio samples when triggered. The elephants both investigated the devices with their trunks but showed markedly different levels of interest. The older male repeatedly triggered the sounds, while the younger animal reached up to do so once or twice and then moved away. We had provided two identical devices explicitly to avoid competition, but the elephants appeared to demonstrate individual preferences as to whether or not they wanted to engage, rather than rivalry over access to the system. Perhaps this is unsurprising, since humans also have distinct tastes in regard to music and background noise. In relation to such individual preferences, the pervasive nature of sound in a shared environment is one of the challenges associated with the provision of auditory enrichment.

We realised that as well as a binary on/off control, we needed to design an analogue control to capture elephant trunk tip movements and provide a graduated response – this was particularly important for acoustic output, so the elephants would be able to express preferences across a spectrum of acoustic variability – for example, controlling graduated volume or pitch.

We tested Valli's interest in novel moving installations by suspending thick ropes from the rafters. She interacted with these ropes, but we realised that capturing the detail of her trunk movements using simple sensors would be difficult within our timeframe. We therefore decided to develop a system with limited linear movement.

Creating a robust moving interface element for an elephant requires advanced technical skills and specialised equipment. Our first attempt therefore aimed to avoid moving parts by using capacitance sensing that changed along the length of the interface, such that one end represented "minimum" and the other "maximum" output intensity. We created a device with stripes, where each stripe had different embedded sensitivity and distinct tactile qualities (Fig. 5). However, this technique relied on covert sensing, so the mapping between user action and system output did not appear to be sufficiently transparent for an elephant to comprehend. Moreover, in the animal enclosure the sensor's performance was unpredictable, requiring regular recalibration. We concluded that an interface element should be explicitly actioned so that the elephant was clearly making a choice to trigger it – such as a switch that could be physically moved to one position or the other, and remain there.

Our subsequent prototypes were based on *sliders*, which humans often use in the context of DAWs (Digital Audio Workstations) in order to control sound effects, such as volume and pitch. Sliders have obvious boundaries that are both visual and tactile, as well as a thumb (handle) that protrudes, tempting the user to touch it; even a light touch will move the thumb along the track. We hypothesised that sliders would be easier for an elephant to use than knobs, for example, because they “*solicited action and in doing so, facilitated… learning*” (in other words, how to use the controls) (French et al. 2020).

An early version attempted to capture input via a variable resistor, designed in the form of a metal wheel that could be rolled along a length of semi-conductive material. Although this worked fine on a small scale, it was not fit for purpose as it was too fragile for an elephant enclosure. The final version was developed with technical support from London Metropolitan University Cass Works (a specialist resource for rapid prototyping). We crafted an analogue control using an old drawer slider, which had a much smoother mechanism, and embedded ultra-sonic range finders within the frame in order to track the slider position. The slider thumb was made from an old scrubbing brush, chosen for its texture and smell. The slider movement was mapped to both volume and quality of tone, with the default position being silent (Fig. 5).

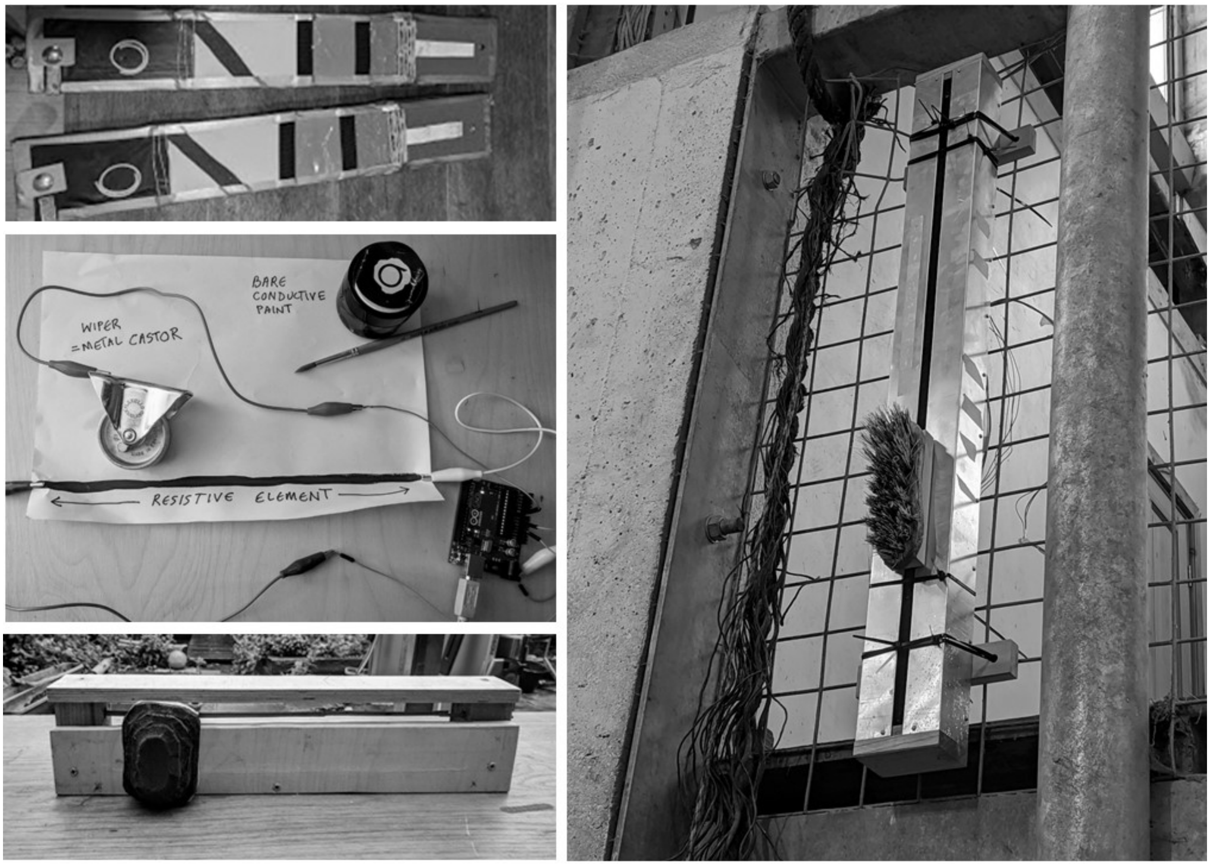

Figure 5: Slider prototypes

When we first installed the slider device inside the elephant shed at Skanda Vale and waited expectantly for the elephants to interact with the new system, they did not do so. However, subsequent late evening video footage, recorded when researchers and keepers had left, revealed that both elephants (Valli and Lakshmi) *were* interested in playing with the new device (Fig. 6). Valli was the first to explore the slider closely with her trunk. One of her early actions was to remove the scrubbing brush on the thumb and use it to scratch herself. The keepers subsequently fixed the brush more securely. A few days later, footage shows Lakshmi sliding the thumb up and down the track in the middle of the night.

By this time, we had disabled the audio to avoid inadvertent disturbance, so we ended up testing the mechanism and its potential for offering a pleasing kinaesthetic experience, rather than establishing whether the elephants would try to manipulate the auditory output.

Figure 6: Valli and Lakshmi playing with rope and slider.

Conclusions

Using a Research through Design and Craft approach enabled us to reflect deeply and regularly as we were iterating our designs and crafting interactive objects for elephants. As we moved towards our goal of filling some “elephant experience gaps” with novel enrichment, we focused on the perspectives of particular elephants, rather than trying to develop a one-size-fits-all-elephants solution. We used our experiences in the field to inform and inspire future designs, moving from speculation to manifestation to further speculation.

All the interfaces we created required the elephant to perform an action. Those that provided immediate haptic or kinaesthetic feedback appeared to generate the most interest and repeated playful behaviour (ropes, slider, vibrating pad). We suggest that performative and tactile aesthetics are very important qualities for a device aimed at elephants, as our research observations suggest that they have the potential to give the user a pleasurable experience. A device that affords such an aesthetic experience is therefore more likely to meet its enrichment goals, as the design will encourage the animal to play with it. Beyond designing interactive enrichment for elephants, we suggest that these observations have a wider resonance in the field of interaction design, particularly with respect to designing for non-human animals.

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